FOREST HEALTH PROTECTION
Pacific Southwest Region

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Biological Evaluation of the Gooseberry Forest and Meadow Restoration Project Summit Ranger District, Stanislaus National Forest

Introduction

The Gooseberry Project is a forest restoration and improvement project on about 4900 acres, including Dodge Ridge Winter Sports Area (DRWSA). The Gooseberry Project is located on Summit Ranger District, Stanislaus National Forest (T4N R18E Sections 13, 14, 23, 24, 25, 26, 35, and 36; T4N R19E Sections 15, 16, 17, 18, 19, 20, 21, 29, 30) (Appendix A). The elevation ranges from 6300 to 8600 feet. Current forest conditions are not considered ecologically sustainable and stable: pest incidence is extremely high, species diversity is slowly being reduced – these conditions are anticipated to increase in subsequent years with no action. Forests within the project are assessed to be highly susceptible to pest-associated mortality which influences future stand structure and composition. Invasion of exotic pathogens, composition shift, and encroachment have also affected the abundance of uncommon species in the landscape.

Project objectives outlined in the PIL (PIL 2009):

- Reduce wildfire potential in the project area, with emphasis in the WUI and DRWSA.
- Amend WUI boundaries as necessary for strategic and logical fuelbreaks to create effective fire fighting areas.
- Reintroduce fire into fire-adapted ecosystems.
- Improve and enhance species composition to favor more fire-resistant species, reduce inter-tree competition and increase tree vigor to resist insects, diseases, and drought.
- Protect/enhance/maintain wildlife habitat with an emphasis on TES species
- Identify transportation needs for the project area
- Reduce or eliminate the spread of noxious weeds in the project area.

At the onset of the project, Forest Health Protection was requested to provide input concerning insect and disease identification, and possible management options for mitigation of associated mortality in the Gooseberry area. Only the fourth bulleted item will be thoroughly addressed in this document; other items may be mentioned but are not the focus of this report. While vegetation of Dodge Ridge Winter Sports Area is similar to other locations of the project, it will be addressed as a separate item.

Proposed project area is predominantly mixed conifer (fir) type at the lower elevations, to red fir forest type at higher elevations. Red fir, red fir/white fir, and red fir/white fir/Jeffery pine (*Pinus jeffreyi*) vegetation types comprise the largest proportions. White fir/sugar pine/red fir type account for only a small proportion at the lower elevations. Incense cedar (*Calocedrus decurrens*) and Black Oak (*Quercus kelloggi*) are minor components within Ponderosa pine (*Pinus ponderosae*)/white fir stands; brush species (mountain whitethorn (*Ceanothus cordulatus*), and bitter cherry (*Prunus emarginata*)) are prolific in large open clearings. Mountain hemlock (*Tsuga mertensiana*) and western white pine (*Pinus moniticola*) are scattered along north-facing slopes, intermixed among pines and firs at the highest elevations (>8000 feet). Western white pines and hemlocks have limited distributions within the Gooseberry Project area. Both species occur in less than 5% of the project area. In riparian areas such as Round Meadow and Crab Meadow, quaking aspen (*Populus tremuloides*) grow in dense thickets or among pines. Jeffrey pines are found frequently on south-facing slopes, but white fir overtops developing pine seedlings in the understory and mid-canopy.

Red fir is a major forest type within the Gooseberry Project. Red fir is a high elevation species that grows between elevations of 5000 to 9000 feet – areas of heavy snowpack and long winters (Fowells 1965). Within the project, red fir is intermixed with Jeffrey pine, mountain hemlock, and white fir. At the highest elevations, red fir is the dominant species with variable aged trees with moderate to high stand densities. Red fir often grows in these conditions with few canopy openings and minimal vegetation in the understory (Fowells 1965). Stands at the highest elevations are impenetrable barriers of mountain whitethorn (see Figure 1).

Figure 1. Red fir community typical of many sites in the Gooseberry project. Note thick mats of mountain whitethorn in the brush layer.

Observations and Discussion

Insect and disease identification and distribution were assessed by aerial survey, ground surveys, and available stand examination data. Ground surveys were conducted during the summer of 2009 in various locations around the project. Variable radius plots were used to estimate stand density, average diameters, and pest-associated mortality. Time of death for trees was estimated by foliage color, foliage retention, and insect lifestage under the bark (if present). Cut stumps or broken snags were destructively sampled for root diseases or other decay pathogen. Dwarf Mistletoe infection levels in tree crowns were estimated using Hawksworth Dwarf Mistletoe Rating (DMR) system (1978).[1]

Aerial Survey (conducted by Forest Health Monitoring, Davis, CA) reports damage/mortality as seen from the sky. Surveys only report trees killed from the previous year that have started to fade. Recent tree mortality within and surrounding project boundaries were detected in 2005 by aerial survey (FHM 2005). In 2005, nearly 20,000 acres of mixed conifer (fir dominant) were detected with damage associated with fir engraver and western pine beetle. Tree mortality was primarily moderate, 1-10 trees per acre. In 2006 and 2007, mortality decreased dramatically to low levels in the surrounding area. Mortality detected in 2008 and 2009 slightly increased as a combination of drought stress, root disease, and fir engraver activity caused top-kill and small patch mortality in and around Gooseberry.

Based on stand examination information taken by district personnel, a majority of the general forest within the Gooseberry project is within recommended ranges of normal stocking, but high incidence and continued physiological stress from insects and pathogens may increase mortality above background levels. Strategies that alter stand compositions to favor more fire and droughtresistant species (pines) and reduce inter-tree competition, should boost individual tree vigor to resist insects, diseases, and drought. Basal areas and stand density index are occasionally above thresholds where pest-related mortality could trigger risk; only 10 units exceeded 250 ft^2/acre and two-third of units had <400 SDI. Trees per acre (TPA) varied the most with a range of 20 to 3000 trees per site.

[1] As the fir dwarf mistletoe does not commonly produce brooms, it is frequently not possible to use the Hawksworth rating system to rate mistletoe infection of true fir. This lack of visible symptom of mistletoe infestation, FHP have frequently encountered small firs that would rate a Hawksworth 6 if examined up close, and rate a Hawksworth 0 if observed from over 20 ft. The slight swellings and the root wounds caused by the mistletoe plants become the entry points for the branch killing *Cytospora* fungus (Scharpf, 1969). Since no other rating system is available to estimate DM infection levels for true fir, the Hawksworth rating is used as a surrogate.

Insects and Diseases

Dwarf Mistletoe (DM)

There are two distinctly separate dwarf mistletoe subspecies that infect white fir and red fir trees. Red fir and white fir dwarf mistletoes are seed-bearing plants that only parasitize their specific host species. The plants do not live long without living host tissue, which they depend on for support, food, nutrients, and water. Dwarf mistletoes produce sticky seeds that are explosively discharged from the fruit through the buildup of turgor pressure. Seeds have been recorded to travel as far as 100 feet, landing on needles or branches of hosts. As the mistletoe develops, signs may not be visible for up to 5 years before shoots emerge. Horizontal spread in a stand without overstory infection is limited due to the dense foliage of true firs. However, infection within individual trees will intensify as seeds move up and down within crowns (Maloney & Rizzo 2002).

Symptoms associated with dwarf mistletoe for both host types are similar, but not easily visible in the crowns of firs. In contrast, the dwarf mistletoes of pines produce large brooms and branch deformity that are conspicuous. In overstory trees, DM was only confirmed on lower branches where plants or branch swellings could be seen. Assessing DM ratings with binoculars in the upper crown is not accurate, therefore only estimations were made. On smaller trees, plants were easily visible and annual infection was counted upward. Most overstory trees examined along Crabtree Road averaged 4-5 DMR. Live crowns were less than 50% for some, overall condition appeared fair to poor. The highest DM ratings and trees per acre infected were found most often in red fir stands (see Figure 2). In one unit, over 3800 trees per acre recorded of which 2700 were infected (unit 051653Goose0072). Unit inventories found that red fir stands consistently had, the highest SDI, highest number of trees with DM infections, and highest percentage of the stand infected – a few at 100% infection. The natural high density of red fir stands contribute to infection spread by increasing DM seed interception on preferred hosts. Without treatment, current stand conditions and high inoculum potential will lead to increased DMR within the next twenty years.

Figure 2. Representative high density red-fir stand in the project area. Note dead branches ("flags") from *Cytospora* infection, and bright yellow plants within tree crowns indicate severe dwarf mistletoe infection in all size classes.

Cytospora is a weak parasite that infects hosts already debilitated from prior damage or dwarf mistletoe infection. Typical symptoms of Cytospora damage are branch dieback, top-kill, or sunken dead spots along branches (Scharpf 1993). *Cytospora* canker was evident in varying degrees on red firs ("flagging") — from as few as 5% of branches to 30% throughout the crown. Percent of Cytospora associated with prior dwarf mistletoe infection could not be confirmed, but much of the DM Hawksworth ratings use flags as evidence of DM presence.

Annosum Root Disease

Although Heterobasidion (*Heterobasidion annosum*) S-type is native, the prevalence of this fungus within Gooseberry is not considered within historic limits that may have existed before human activities. Annosum S-type affects white and red firs, as well as hemlock. Annosum root disease was most often detected where large diameter white and red fir trees had been cut and the stumps not borate treated. Fresh conks were found in large older stumps. Many annosum pockets were found in old timber sale areas or past salvage areas (see Figure 3). Disease centers displayed classic symptoms of infection: gap opening of dead trees in the middle encircled by dead or snapped trees, and fading trees along the outer edges.

Figure 3. Annosum Root disease fruiting bodies located inside of old cut red fir stumps.

Fir engraver

Scolytus ventralis is considered non-aggressive compared to *Dendroctonus* species, since they are attracted to volatiles emitted by weakened trees rather than aggregation pheromones (Macias-Samano *et al* 1998); however, widespread outbreaks of this beetle do occur during prolonged drought events or hosts experiencing other significant physiological stresses (Wood et al. 2003, Furniss and Carolin 1992). Most often fir engravers are considered the final agent of demise, not usually the primary factor. Dwarf mistletoes, root or foliage diseases, or other prior damage will predispose trees to fir engraver attack (Wood et al. 2003). Trees compromised by root disease are often eventually killed by fir engraver. Larger fir trees will

often be top-killed before they are eventually mass-attacked. Contributing stress factors such as drought in combination with moderate to heavy true mistletoe (*Phoradendron pauciflorum*) infection will significantly increase risk, of white fir mortality especially if drought is severe (Felix et al 1971). Red fir is not infected by the true mistletoe. White fir is the only member of the family Pinaceae to be infected by true mistletoe.

Figure 4. Group kill of red fir by Fir Engraver, assessed fade in 2007.

Fir engraver activity was noted throughout the project area, in nearly all dead or fading red and white fir trees. Recent fading trees had live brood under the bark or distinctive gallery patterns. Attacked trees were of variable diameters, but clumped in groups that suggested stand condition stress or root disease centers. Most dead trees were found with fir engraver and woodborer galleries, or dwarf mistletoe plants, but not always confirmed with root disease.

Drought is a significant contributor to increased host susceptibility to bark beetle attack or eventual mortality from root disease. Drought (water stress) reduces the tree's ability to respond to attack, allowing insects or disease to overcome host defense mechanisms. In California, drought is an inciting factor that triggers pest outbreaks and exacerbates already stressed trees (Smith 2007). When droughts become prolonged over multiple years, tree mortality has been shown to increase significantly in mixed-conifer forests (Guarin and Taylor

2005). Fir engraver associated morality is strongly correlated with declining precipitation (Felix et al 1971). Drought effects should be included when developing long-term management that improves stand resiliency during times of reduced precipitation.

White Pine Blister Rust

With the exception of white pine blister rust (WPBR)(*Cronartium ribicola*) all pests previously listed, are native to western forests. Associated mortality of native fungi can exceed desirable or natural levels if conditions are suitable for fungal growth. Mortality associated with WPBR is highly undesirable due to an absence of biological controls or conditions to keep infection from spreading. WPBR-caused mortality of small diameter sugar pine or western white pines was observed, top-kill or branch flagging was most often noted on larger hosts. Western white pine abundance in the project area is slowly decreasing due to WPBR. From project stand exams, more than 50% percent of western white pines were infected with White Pine Blister Rust. Infection levels ranged from low to severe, mortality was minimal. Identification of potential resistant WPBR individuals and replanting of white pines within Gooseberry should be strongly considered to maintain species diversity valuable wildlife food source.

Plantations

Plantations of Jeffrey pine and red fir-white fir mixes are located along Crabtree Road (4N26) and Road 4N34 were established between 1966 and 1996. Depending upon aspect, red fir natural regeneration or mountain whitethorn is crowding planted trees. Some plantations have been thinned previously, but currently need treatment to reduce inter-tree competition. Dense understory brush, crown overlap, and overstocking from natural fir regeneration are indicators that stands are reaching stocking. Large mature red firs border plantations and provide a natural seed source but dwarf mistletoe inoculum as well. Depending upon aspect, some (pine) plantations are growing vigorously with only brush competition while others are becoming congested with naturally seeded fir. Minor dwarf mistletoe infections were detected in the plantations, but growth was limiting in some locations due to overstocking rather than pests.

Dodge Ridge Winter Sports Area (DRWSA)

This recreation area is located within the Gooseberry Project (Township 4N, Range 18E, Sections 13, 23 & 24; Township 4N, Range 19E, Sections 17, 18, 19 & 20). Red fir forest type dominates most of the recreation area, where ski runs and chair lifts are located. As with most of the red fir communities in the project, dwarf mistletoe is a major concern. Dwarf mistletoe has affected all sizes and age classes compromising much of the structural stability and optimum growth, while reducing resistance to infestation by other damage agents. Stands currently average 3 DMR in the larger size classes, and infection is ubiquitous on the developing understory. Most stands within the DRWSA have been assessed to be in need of forest health improvements: to reduce DM inoculum source, rejuvenate declining sugar and western white pine, and protect developing trees from mechanical damage by visitors. The widespread severe incidence of DM in many units is deteriorating the quality of the understory, increasing mortality rates – especially of the mature overstory, and altering the landscape of the recreation area. Hazard tree removals are conducted frequently in this area to provide public safety, but do not address the progression of DM downhill and increased severity in the regeneration. Additionally, hazard tree removal operations that do not involve an approved borate treatment will make the root disease situation worse.

Suggested management in the red fir is focused on sanitation, involving regionally approved borate applications and reduction of dwarf mistletoe infection. Recommendations for the general forest improvement are provided, but specialized alternatives to preserve the designed recreation layout are needed. Removal of the most highly DM infected trees (ratings of 5-6) is imperative – all size classes if necessary – to reduce inoculum in the stand and slow down infection in residual trees. Sanitation and density reduction treatments will be effective to improve growth and stand resiliency, while maintaining current stand composition without dramatic alteration to the landscape. However, sanitation in the fir stands that does not include a borate application to cut stumps will exacerbate root disease presence.

Forest Health Protection concurs with district land managers on suggested treatments within DRWSA, understanding the needs of wildlife criteria, aesthetics, and fuel reduction. Identification and protection of potential rust-resistant candidates of western white pines would also be a benefit as valuable seed sources for future planting needs. Temporary closures or fencing (possibly 20 years) are needed to prevent visitors from damaging new plantings and protect residual trees from further disturbance.

Suggested management options are outlined in proceeding pages. If you have any concerns or require further information or additional assistance, please do not hesitate to contact us.

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Management Alternatives for General Pests in Gooseberry Project (including DWRSA)

No Action

Under the no action alternative, all damage and mortality associated with insects and pathogens will continue. The impacts associated with dwarf mistletoe, bark beetles, root disease, and *Cytospora* would only be treated where trees are public hazards. While there are benefits to wildlife and maintaining structural diversity, the current high levels of DM in the overstory will perpetuate the current undesirable levels of DM infections in the next generation of canopy trees stagnate their growth or killing them before they can reach maturity. Individuals would not grow suitably if they are physiologically hindered and die before mature characteristics are developed.

Dwarf and True mistletoes have been perpetuating in true firs, in the project area for a very long time. Smaller trees were observed with multiple DM infections and many appeared to have been re-infected for several consecutive years. Average mistletoe infection among stands range from low to severe, and allowing infections to intensify increase mortality risk from other damaging agents such as Fir engraver or Annosum root disease (Hawksworth and Weins 1996). While infection may not move quickly within the understory, heavily infected overstory trees will continue to shower seeds down on smaller trees. Infection rates will continue to increase in overstory and regeneration, reducing growth, and making trees more susceptible to other damage agents or environmental events. No action alternatives may lead to unacceptable mortality levels (see Appendix B) that interfere with stand development and recruitment of trees into large size classes. There may be areas that removal of infected overstory will reduce canopy cover, but continual re-infection of regeneration is not desirable for long-term sustainability.

The **no action** alternative may increase public and personnel safety hazards, and prolong stand maturity. Increases in woody material from rapid tree mortality – primarily due to insects – would occur. Low intensity wildfires would cleanse some areas of dwarf mistletoes and root disease infections, but if severe, stands may be completely altered and unable to return to forested conditions. Public and district personnel in the area will be at higher risk as dead trees eventually fall from increased pathogen incidence that compromise structural integrity (see Figure 7). Host trees will continually be affected by root disease further perpetuating presence in the stand. Failure to control root disease centers will lead to perpetuation of brush field openings that will eventually be filled with non-host tree species, but at a pace that will take a century or more. High forest cover and seedling recruitment on the landscape would be

hindered if regenerating trees are unable to survive to maturity due to severe DM infections or root disease presence. Regeneration would also be hindered in small open clearings due to dead wood accumulation.

Figure 7. Tree failure due to root disease. Note loss of root structural support and anchor to the ground.

There is an intricate complex mix of pests, stand, and site conditions within the Gooseberry project. Impacts of insects and diseases have been assessed by the district and FHP as significantly affecting growth and productivity; therefore management strategies should include these disturbance factors as they will continue to influence resulting conditions. Consideration of infestation severity or practicality of treatment will help prioritize areas for treatment as needed.

Treatment Alternatives

Effective treatments would need to focus on sanitation due to the prevalence of dwarf mistletoe and root disease, rather than stand thinning to set densities. This direction requires very selective, individualized tree management rather than stand approaches. Tree selection can be assessed using risk rating guidelines of the crown condition by Ferrell (1989). These guidelines can help managers evaluate tree vigor and growth, but also give confident estimates of their pest infection severity or susceptibility. Reducing insects and pathogen-associated mortality to tolerable levels and mitigating their impacts would meet the long-term restoration objectives of this project. While true fir forest types can still be healthy at higher stand densities, significantly reducing stocking densities should improve stand resilience when annual precipitation is abnormally low – especially in California, where drought events are cyclic. In an evaluation of FIA plots in the red fir types in the Stanislaus National Forest, it was shown that stands below 500 SDI experienced less mortality than those with greater than 500 (Egan 2008).

In some areas, the removal of weak, severely stressed trees, or heavily infested individuals should reduce stand density while reducing DM inoculum and distribution.

Bark Beetles

To reduce bark beetle risk in these forest types, thinning to less than 40-70% of normal basal area stocking (Zhang et al 2007) or less than 60% of maximum SDI will suffice in preventing large-scale mortality. Planning for longer return intervals (20 years plus) between treatments helps ensure stands remain resilient and productive under severe conditions, like drought. Removal of diseased, infected, weakened, or other severely stressed trees would also reduce bark beetle risk as well as pathogen infection. It may be necessary to treat brush or other competing vegetation to improve resource allocation where they are limited. While westside Jeffrey pines seem to have lower risk than their eastside counterparts, susceptibility is similar if trees become stressed or weakened. Stands with fairly high basal areas are at more risk for insect attack (Kolb et al 1998), so reducing overall stocking would improve limited resource distribution and provide space for growth. Treat all green pine slash, generated by thinning or pruning to, reduce the risk of subsequent pine engraver attack (*Ips* species). Slash created in the summer and late fall should be lopped and scattered, piled and burned, relocated, or chipped.

Annosum Root Disease

There are a variety of treatments for root disease that can be considered. Most importantly, treatment of freshly cut conifer stumps (>12 inches) with a registered borate compound prevents establishment of new infections. The borate prevents the spores of the fungus from germinating. Annosum root disease cannot be eliminated but it can be suppressed, and mortality mitigate the establishment of new pockets. Treatments in identified root disease centers include: reducing host composition (ex: favoring pines), planting non-host species, and improving overall stand vigor. Reducing host abundance throughout as much of the infected areas as possible will prevent perpetuation of an Annosum problem. Planting non-host tree species will create spatial buffers against spore distribution above ground, and root-to-root contact. Host group selections can be utilized to clear small pockets of disease then replanted with pines (preferably rust resistant) to break up areas of host homogeneity. In Gooseberry, reduction of fir hosts and inter-planting of pine would create the spatial diversity needed. Thus treatments that decrease susceptibility to pathogens and bark beetles will also achieve other project objectives. Treatment priority setting should include root disease centers wherever they are located. While trees have natural mechanisms to reduce the impacts of root diseases, damage or stress from other agents will compromise the trees ability to ward of root rot fungi. To reduce disturbance, identified diseased trees can be harvested during thinning operations rather than removed in a second entry (after they have died and become hazards).

White Pine Blister Rust

Candidate WPBR resistant trees should be thinned around the drip line, and squirrel-banded to increase longevity and ability to produce harvestable seeds. If trees are found to be diseased after genetic screening, bands can be removed.

Dwarf Mistletoe

Effective dwarf mistletoe management relies on using the appropriate options for each individual situation or stand. Consideration must be given to stand structure and composition in addition to the level and distribution of infection. Knowing where the infection is, and its severity, are necessary before deciding what to do. One or a combination of the options described below will normally minimize damage from dwarf mistletoe. Options are to either remove the infested overstory and manage the understory, or retain the infested overstory and accept the continued infection and eventual loss of the understory of that species.

1. Removal of infected residuals. Many of the most severely infected stands are the result of past logging practices where infected trees were left in regeneration units throughout the life of the stand. Removal of these trees is extremely important to prevent the gradual destruction of young stands around them; this should be a high priority.
2. Sanitation thinning. In true fir and pine types, the most heavily infected trees should be removed. This eliminates trees at high risk for bark beetle attack, reduces overall stand infection, and increases the growth of residuals. Released trees on good sites may outgrow the mistletoe infection. It is not necessary to eliminate all mistletoe infection as long as no overstory source of dwarf mistletoe seed is present.
3. Promoting species diversity. Because mistletoes are host specific, altering the species composition in mixed stands can reduce or eliminate the long term impacts from this pest. Planting also offers an opportunity to establish tree species resistant to dwarf mistletoes which may be present in bordering trees or stands. In those areas of this project where the red and white fir species intermix, it might be practical to favour one species over the other, if the overstory DM is predominately of one subspecies (since red fir subspecies of DM does not infect the white fir and vice versa).
4. Use Buffer Zones. Any management strategy for dwarf mistletoe should include steps to prevent the parasite from moving back into treatment areas from adjacent infected trees. Buffer zones may occur natually or be man made, and are any areas that do not contain host material susceptible to the mistletoe(s) present. Examples include: meadows, lakes, rivers, openings, ski runs, clearings, roads, and plantings of non-host trees.

Selective treatments for Individual Trees. Branch and broom pruning are optional treatments if only a few individual trees were affected with Dwarf Mistletoe. For large scale general forest treatments like are needed here, these would not be practical or feasible. However, where an isolated large overstory tree is discovered to be surrounded by heavily infested regeneration, it would be possible to girdle the canopy tree and utilize it as a premature snag. Subsequently the heavily infected halo of young DM infested trees below should be felled.

Cultural Treatments. Recreation areas are a valuable source of income for land owners, treated areas may need respite from public use for long-term recovery. Successful mistletoe treatment and thinning are sometimes incompatible with recreation management, and partial treatments are usually not biologically or economically sound. It may be advisable to close an area so that treatments can be carried out properly and stands revegetated where necessary. Although restricting an area will be costly, benefits of a healthy stand may offset the temporary loss of the site. Severely infected campgrounds or ski runs may continue to decline, creating greater public hazard risk. It may be cost effective to revitalize stands where possible, rather than wait until public safety forces closure.

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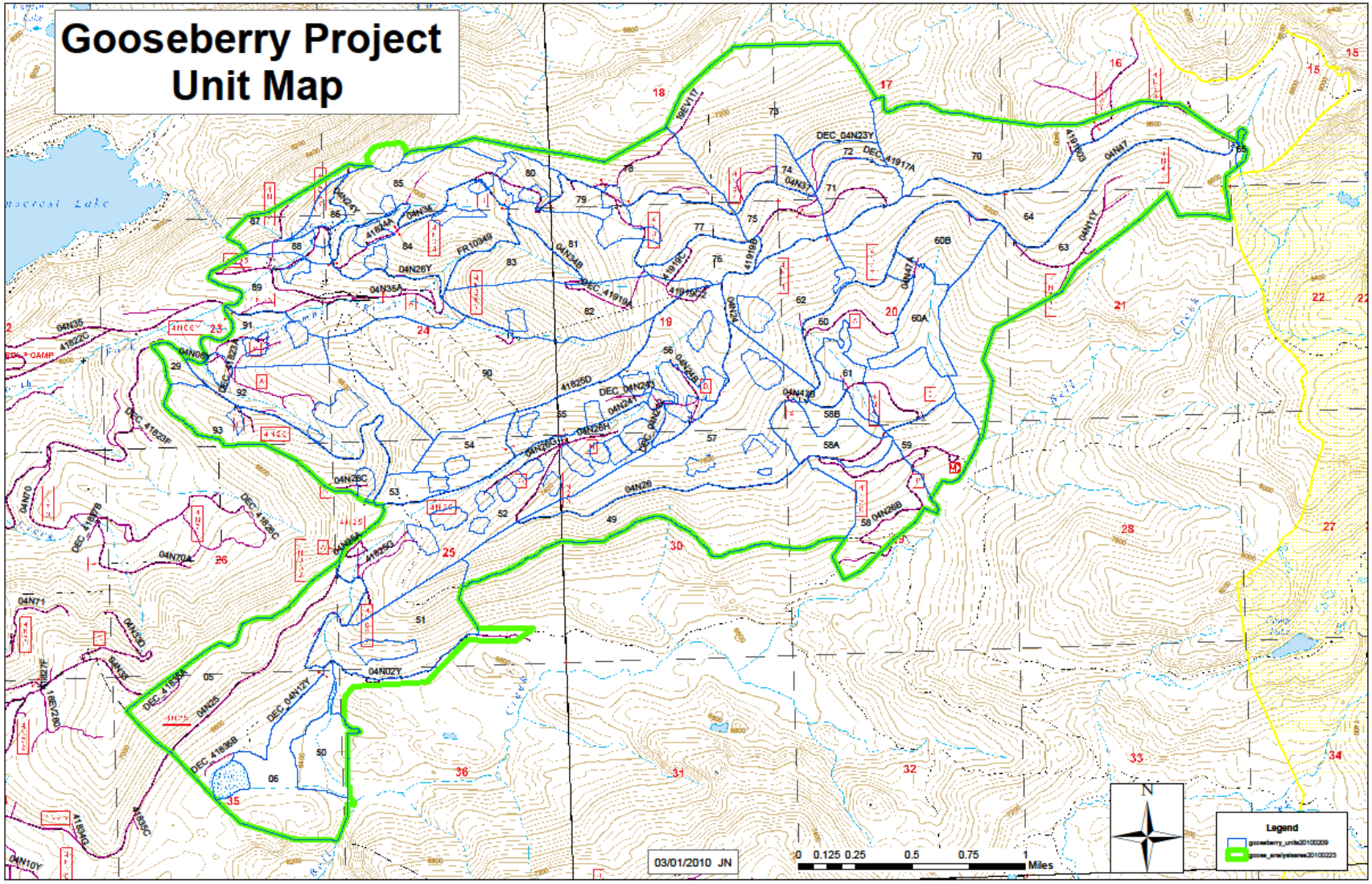
Appendix A. Map of Goose berry Project, Summit Ranger District, Stanislaus National Forest.



Appendix B. Calculating Mortality of True Firs infected by Dwarf Mistletoe (*Taken from* Hawksworth, F.G., J.C. Williams-Cipriani, B.B. Eav, B. Giles, R. Johnson, M. Marsden, J.S. Beatty, and G. Shubert 1992. Interim Dwarf Mistletoe Impact Modeling System: User Guide and Reference Manual, USDA Forest Service, Forest Pest Management, Methods Application Group, Report MAG-91-3.)

Resulting 10-year mortality percentages of true firs based on DMR and DBH are shown below. The resulting percentage is converted to trees per acre and compared to background mortality.

Dwarf Mistletoe Rating	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Percent mortality of small trees (DBH < 9 inches)	0.0	0.8	2.8	6.1	10.5	16.2	23.1
Percent mortality of large trees (DBH >= 9 inches)	0.0	0.7	2.3	5.0	8.8	13.5	19.2